REMARKS

Claims 1-3, 5-10 and 12-20, all the claims pending in the application, stand rejected on prior art grounds. Applicants respectfully traverse these rejections based on the following discussion.

I. The Prior Art Rejections

Claims 1-5, 8-12, and 15-18 stand rejected under 35 U.S.C. §102(b) as being anticipated by Fujii (U.S. Patent No. 5,574,280), hereinafter referred to as Fujii. Claims 7, 14, and 20 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Fujii, in view of Berger, et al. (U.S. Publication No. 2004/0065826), hereinafter referred to as Berger. Claims 6, 13, and 19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Fujii, in view of Christy (U.S. Patent No. 3,119,707), hereinafter referred to as Christy. In addition, the Office Action relies on Matsui (U.S. Patent No. 6,758,900), hereinafter referred to as Matsui, and Collins (U.S. Patent No. 4,509,451), hereinafter referred to as Collins, as secondary references. Applicants respectfully traverse these rejections based on the following discussion.

The claimed invention surrounds a partially completed integrated circuit structure, having topographical features such as vias, with a precursor organic metal gas and then directs an angled electron beam at the partially completed integrated circuit structure to create secondary electron beams as the angled electron beam strikes the sidewalls of vias. The secondary electron beams break down the precursor metal gas to form a metal coating, without damaging the top layer (or underlying layers). This process directs the

electron beam at an angle sufficient to cause the electron beam to strike only the sidewalls of the vias and prevent the electron beam from reaching the bottom of the vias, so as to not damage the vias during the metal formation process. After the protective metal layer is formed, the invention directs an ion beam at the partially completed integrated circuit structure to form a groove within the top layer and allows inspection of the cross sections of the vias exposed by the groove.

More specifically, when the primary electron beam hits a surface, the emitted electrons that have an energy level less than 50 eV are called secondary electrons, and those with an energy level of 50 eV or higher are called backscattered electrons. The lower power secondary electrons are usually much more abundant relative to backscattered electrons. The same electron beam can be shared for both imaging and deposition, where the direct beam is used for imaging, and the indirect beam is used for metal deposition to form a true protection layer without deforming or damaging the underlying resist feature because of the nature of the low energy of the indirect beam. The indirect electrons initiate the metal deposition (using the precursor gas). Thus, the present invention provides the indirect electron beam as an energy source to initiate metal coating with the existence of precursor gas, and also offers a coating technique to cover a wide range applications on the variety of materials, topography, shapes, etc.

In the rejection, the Office Action argues that Fujii discloses a method of observing a sample surface using an electron beam and an inorganic metal gas to deposit a metal film on the sample surface. In addition, the Office Action argues that Berger discloses an imaging system comprising an electron beam oriented at angle between

thirty and sixty degrees; and, that Christy discloses an electron beam accelerated at 225 volts for forming a metal film. However, neither Fujii, Berger, nor Christy, individually or in combination, teach or suggest the use of secondary electron beams, which are created when angled electron beams strike topographical features, wherein the secondary electron beams break down precursor metal gas to form a metal coating. Rather, unlike Applicants' invention, Fujii discloses secondary *particles* formed by an *ion* beam, wherein the secondary particles are used to detect and image a sample.

In addition, the Office Action argues that Matsui and Collins disclose the use of electron beams in assisted CVD deposition. However, neither Matsui nor Collins teach or suggest directing an electron beam at a structure to create secondary electron beams as the electron beam strikes topographical features of the structure. The Office Action also argues that Christy discloses that all metals and some insulators will emit secondary electrons when bombarded by electrons. However, the secondary electrons of Christy are not used to break down metal gas to form a coating; rather, the secondary electrons are removed from the target substrate for the purpose of attracting other electrons to the target surface to produce a thin film. Furthermore, the electrons disclosed in Christy are not used to form a metal coating – the electrons are used to form an insulative film. Therefore, as explained in further detail below, Applicants respectfully submit that the prior art of record does not teach or suggest the claimed invention.

A. Independent claim 1

The Office Action argues that Fujii discloses use of an electron beam irradiation unit to irradiate organic metal gas blown by an organic gas source onto a surface of semiconductor device, and while irradiated with the energy beam source a tungsten film is formed on the surface. The Office Action also asserts that subsequent irradiation at the section with the focused ion beam generates secondary particles, which are detected by a detector. In addition, the Office Action argues that Berger discloses a particle beam system for obtaining an image of a cross-section of a workpiece, including a shaped-beam ion-projection column configured to project an image of an aperture onto the front surface of the workpiece, and further includes a focused-particle-beam imaging column, which is an electron beam provided by a scanning electron microscope. Further, the Office Action argues that Christy discloses a method for deposition of thin films that includes the use of a substrate located within an evacuated chamber, that is enveloped with the vapor molecules of a metal-organic compound, which is irradiated with a beam of electrons accelerated at 225 volts, whereby a metal film is formed as the vapor molecules adsorbed on the substrate are decomposed by the electron beam.

Such features are defined in independent claim 1 using the following language: "[a] method of inspecting topographical features of the top layer of a structure, said method comprising: surrounding said structure with a precursor metal gas; directing an angled electron beam at said structure to create secondary electron beams as said angled electron beam strikes sidewalls of said topographical features, wherein said secondary electron beams break down said precursor metal gas to form a metal coating on said

structure; directing an ion beam at said structure to form a groove within said top layer of said structure; and inspecting said topographical features exposed by said groove in said top layer of said structure."

The Office Action highlights Fujii's use of an electron beam to irradiate organic metal gas blown onto a sample surface, wherein a metal film is formed on the sample surface (column 2, lines 40-49). Moreover, Fujii explains in column 4, lines 34-45 that a predetermined area of the sample is removed by ion sputtering, wherein a cross-section of the sample is exposed. Fujii also discloses, in column 1, lines 7-12, 28-32, and column 4, lines 4-8, that secondary particles are utilized for imaging the sample surface. However, nothing in Fujii mentions using secondary electron beams, which are created from angled electron beams, for breaking down precursor metal gas to form a metal coating.

More specifically, unlike Applicants' invention, the "secondary ***particles***" disclosed in Fujii are not created by an ***electron*** beam; rather, the particles in Fujii are created by an ***ion*** beam (column 1, lines 7-12, 28-32). Further unlike Applicants' invention, the secondary particles in Fujii are not used to form a metal coating. The secondary particles in Fujii are utilized to form an image of the sample, i.e., they are detected by a detector to form an image of a section of the sample (column 1, lines 28-32, and column 4, lines 4-8).

The Office Action implies that the secondary particles in Fujii are generated when the electron beam irradiates the sample, wherein the secondary particles contribute to the disassociation of the organic gas, which results in the disposition of the metal coating onto the surface of the sample. Applicants respectfully disagree with this conclusion. As

discussed above, the secondary *particles* in Fujii are not created from an electron beam; rather they are formed from an ion beam (column 1, lines 7-12, 28-32). Further, the secondary particles are not utilized to form a metal coating – they are utilized to form an image of the sample (column 1, lines 28-32, and column 4, lines 4-8). Instead, the metal coating in Fujii is formed with the electron beam (which does not create secondary electron beams) and the inorganic metal gas (column 2, lines 40-49), wherein the method of Fujii is not concerned about damaging delicate components underlying the sample surface.

Conversely, as described in paragraph 39 of Applicants' disclosure, when the primary electron beam hits a surface, the emitted electrons that have an energy level less than 50 eV are called secondary electrons, and those with an energy level of 50 eV or higher are called backscattered electrons. The lower power secondary electrons are usually much more abundant relative to backscattered electrons. The same electron beam can be shared for both imaging and deposition, where the direct beam is used for imaging, and the indirect beam is used for metal deposition to form a true protection layer <u>without deforming or damaging the underlying resist feature because of the nature of the low energy of the indirect beam</u>. The indirect electrons initiate the metal deposition (using the precursor gas). Thus, Applicants' invention provides the indirect electron beam as an energy source to initiate metal coating with the existence of precursor gas, and also offers a coating technique to cover a wide range applications on the variety of materials, topography, shapes, etc.

Therefore, contrary to the position taken in the Office Action, Applicants submit that Fujii does not teach or suggest the use of secondary electron beams, which are created when angled electron beams strike sidewalls of the topographical features, wherein the secondary electron beams break down precursor metal gas to form a metal coating. Thus, it is Applicants' position that Fujii does not disclose or suggest the claimed feature of "directing an angled electron beam at said structure to create secondary electron beams as said angled electron beam strikes sidewalls of said topographical features, wherein said secondary electron beams break down said precursor metal gas to form a metal coating on said structure" as defined by independent claim 1.

With respect to Berger, Applicants submit that this reference is introduced by the Office Action for the limited purpose of illustrating a method comprising the step of orienting an electron beam at angle between thirty and sixty degrees (as taught by dependent claims 7, 14, and 20 of Applicants' invention). However, Berger does not discuss the creation and use of secondary electron beams, nor does it mention forming a metal coating using precursor metal gas.

With respect to Christy, Applicants submit that this reference is introduced by the Office Action for the limited purpose of illustrating a method comprising the step of forming a metal film using an electron beam accelerated at 225 volts (as taught by dependent claims 6, 13, and 19 of Applicants' invention). However, Christy does not disclose a method of inspecting topographical features of a structure, nor does Christy mention the creation and use of secondary electron beams.

Thus, it is Applicants' position that neither Berger nor Christy disclose or suggest the claimed feature of "directing an angled electron beam at said structure to create secondary electron beams as said angled electron beam strikes sidewalls of said topographical features, wherein said secondary electron beams break down said precursor metal gas to form a metal coating on said structure" as defined by independent claim 1. Furthermore, because independent claims 1, 8, and 15 are patentable over Berger and Christy, as illustrated herein, the dependent claims that Berger and Christy were presented to reject, i.e., dependent claims 7, 14, 20, 6, 13, and 19, are patentable because of their dependency from patentable independent claims.

In addition, the Office Action argues that Matsui discloses the use of electron beams in assisted CVD deposition to cause a reaction with an organometallic gas to form a film. In support for this contention, the Office Action cites Col. 1, lines 25-28 of Matsui, which provides that CVD based methods of producing a micro three-dimensional structure are classified into three which use light (laser), a focused electron beam, and a focused ion beam, respectively.

However, nothing in Matsui, including the portion cited by the Office Action, teaches directing an electron beam at a structure to create secondary electron beams as the electron beam strikes topographical features of the structure, wherein the secondary electron beams break down precursor metal gas to form a metal coating on the structure. Such a feature is defined in independent claim 1 using the following language: "directing an angled electron beam at said structure to create secondary electron beams as said angled electron beam strikes sidewalls of said topographical features, wherein said

secondary electron beams break down said precursor metal gas to form a metal coating on said structure".

More specifically, Matsui discloses CVD deposition using a focused *ion beam* 4, which as the Office Action acknowledges, is different from an *electron beam* (Office Action, p. 8, para. 2), wherein the ion beam 4 and a material gas 3 form a first-layer deposit 5 (Matsui, Col. 3, lines 33-36, FIG. 1(a)). Matsui does not teach using an angled *electron* beam to create secondary electron beams as the angled electron beam strikes topographical features, wherein the secondary electron beams break down precursor metal gas to form a metal coating. As noted above, the first-layer deposit 5 in Matsui is formed via the ion beam 4 and the material gas 3, not via secondary electron beams created from an electron beam.

Furthermore, the first-layer deposit 5 is formed *before* the secondary electrons 6 of Matsui. More specifically, it is only after the first-layer deposit 5 is formed that ions can impinge on the first-layer deposit 5 to release secondary electrons 6 (Matsui, Col. 3, lines 37-39, FIG. 1(b)). Therefore, because the first-layer deposit 5 is formed prior to the creation of the secondary electrons 6, the secondary electrons 6 cannot be used to form the first-layer deposit 5.

In fact, the secondary electrons 6 are used to form a terrace 7, not a metal coating (Matsui, Col. 3, lines 37-39, FIG. 1(b)). Moreover, the terrace is formed over the first-layer deposit 5 (Matsui, FIG. 1(b)), which, as described above, is formed by the ion beam 4 and the material gas 3, not by the secondary electrons 6.

After the secondary electrons 6 form the terrace 7 over the first-layer deposit 5, the ion beam 4 is once more used to form a second layer deposit 8 over the terrace 7. Again, the secondary electrons 6 are not used to form the second layer deposit 8.

Therefore, contrary to the position taken in the Office Action, Applicants respectfully submit that Matsui does not teach or suggest directing an electron beam at a structure to create secondary electron beams as the electron beam strikes topographical features of the structure, wherein the secondary electron beams break down precursor metal gas to form a metal coating on the structure.

Furthermore, the Office Action argues that Collins also discloses the use of electron beams in assisted CVD deposition. In support for this contention, the Office Action cites Col. 2, lines 13-28 of Collins, which provides for the deposition and growth of microelectronic thin films. The Office Action asserts that the method uses d.c. electron beams to dissociate gas molecules into constituent atoms either directly by electron impact or indirectly by vacuum ultraviolet photons or finally via subsequent rare gas sensitized. Additionally, the Office Action argues that the film donor atoms so formed diffuse to a substrate surface and react to form a solid thin film; alternatively, or in tandem, dissociation of donor molecules on the substrate surface can occur again either via electron impact or photoabsorption and film growth occurs.

However, nothing in Collins, including the portion cited by the Office Action, teaches directing an electron beam at a structure to create secondary electron beams as the electron beam strikes topographical features of the structure. Such a feature is defined in independent claim 1 using the following language: "directing an angled

electron beam at said structure to create secondary electron beams as said angled electron beam strikes sidewalls of said topographical features".

More specifically, the electrons in Collins collide with the reactant gas molecules directly; they do not come into direct contact with the substrate, i.e., the structure having the film formed thereon. As noted in Collins, Col. 2, lines 60-68 – Col. 3, line 1, "[h]igh energy electrons emitted from the glow discharge electron gun collide ***directly with the reactant gas molecules*** thereby dissociating these reactant species and creating free radicals including excited atoms and positive and negative ions. Alternatively the vacuum ultraviolet rare gas photons and rare gas sensitized reactions can cause reactant dissociation via photo-absorption and sensitized gas collisions respectively. Secondary electrons are emitted in the ionizing collisions of beam electrons ***with atoms and molecules***." (Emphasis added). Moreover, as provided in the abstract of Collins, "[t]he electron beams are spatially confined and excite only a localized region above the substrate so that direct plasma bombardment of the substrate is avoided."

Therefore, contrary to the position taken in the Office Action, Applicants respectfully submit that Collins does not teach or suggest directing an electron beam *at a structure* to create secondary electron beams *as the electron beam strikes topographical features of the structure*. The electron beams in Collins collide with the *reactant gas molecules* directly, not the substrate/structure.

Additionally, the Office Action argues that Christy discloses that all metals and some insulators will emit secondary electrons when bombarded by electrons. However, Christy does not teach that such secondary electrons break down precursor metal gas to

form a metal coating. Such a feature is defined in independent claim 1 using the following language: "said secondary electron beams break down said precursor metal gas to form a metal coating on said structure".

Applicants submit that the secondary electrons of Christy are not used to break down metal gas to form a coating; rather, the secondary electrons are removed from the target substrate for the purpose of attracting other electrons to the target surface to produce a thin film. More specifically, Col. 5, lines 33-39 of Christy provide that the arrival of an impinging electron will cause more than one electron (i.e., the secondary electrons) to be removed from the target substrate thereby leaving the substrate with an effective positive charge with respect to its original condition. The effect is therefore to attract electrons to the target substrate surface thereby properly producing a thin film by the polymerizing process.

In addition, Applicants submit that the electrons disclosed in Christy are not used to form a ***metal*** coating – the electrons are used to form an ***insulative*** film. As discussed in Col. 3, lines 31-33 of Christy, an electron gun 16 is directed at a metal film 15 that is to be covered with the insulative film. Further, as noted in Col. 4, lines 3-6 of Christy, the electron beam has the effect of cross-linking the vapor molecules of the polymerizable material used and thereby produces a thin insulative film. As such, the creation of an insulative film teaches away from the metal coating formed in the claimed invention. Accordingly, Christy does not teach the use of secondary electrons to break down metal gas to form a metal coating

Therefore, in view of the foregoing, Applicants respectfully submit that the proposed combination of Fujii and Berger, Christy, Matsui, and/or Collins does not teach or suggest the claimed features of "directing an angled electron beam at said structure to create secondary electron beams as said angled electron beam strikes sidewalls of said topographical features, wherein said secondary electron beams break down said precursor metal gas to form a metal coating on said structure" as defined by independent claim 1.

B. Independent claim 8

Independent claim 8 discloses all of the limitations of claim 1, wherein the "structure" of claim 1 is a "partially completed integrated circuit structure", and wherein the "metal gas" of claim 1 is an "organic metal gas". Furthermore, claim 8 has the additional limitation wherein "cross sections" of the topographical features are inspected. Therefore, claim 8, having the three additional claim limitations described above, is narrower in scope than claim 1. Accordingly, because claim 1 is patentable over the prior art of record (as more fully described above in Section A), and because claim 1 is broader in scope than claim 8, claim 8 is therefore also patentable over the prior art. In addition, it is noted that neither Fujii, Berger, Matsui, nor Collins mention partially completed integrated circuit structures.

Therefore, in view of the foregoing, Applicants respectfully submit that the proposed combination of Fujii and Berger, Christy, Matsui, and/or Collins does not teach or suggest the claimed features of "directing an angled electron beam at said partially completed integrated circuit structure to create secondary electron beams as said angled

electron beam strikes sidewalls of said topographical features, wherein said secondary electron beams break down said precursor metal gas to form a metal coating on said partially completed integrated circuit structure" as defined by independent claim 8.

C. Independent claim 15

Independent claim 15 discloses all of the limitations of claim 1, wherein the "structure" of claim 1 is a "partially completed integrated circuit structure", wherein the "metal gas" of claim 1 is an "organic metal gas", and wherein the "topographical features" of claim 1 are "vias". Furthermore, claim 15 has the additional limitation wherein "cross sections" of the vias are inspected. Therefore, claim 15, having the four additional claim limitations described above, is narrower in scope than claim 1. Accordingly, because claim 1 is patentable over the prior art of record (as more fully described above in Section A), and because claim 1 is broader in scope than claim 15, claim 15 is therefore also patentable over the prior art. In addition, it is noted that neither Fujii, Berger, Matsui, nor Collins mention vias.

Therefore, in view of the foregoing, Applicants respectfully submit that the proposed combination of Fujii and Berger, Christy, Matsui, and/or Collins does not teach or suggest the claimed features of "directing an angled electron beam at said partially completed integrated circuit structure to create secondary electron beams as said angled electron beam strikes the sidewalls of said vias, wherein said secondary electron beams break down said precursor metal gas to form a metal coating on said partially completed integrated circuit structure" as defined by independent claim 15.

II. Formal Matters and Conclusion

Therefore, it is Applicants' position that the proposed combination of Fujii and Berger, Christy, Matsui, and/or Collins does not teach or suggest many features defined by independent claims 1, 8, and 15 and that such claims are patentable over the prior art of record. Further, it is Applicants' position that dependent claims 2-3, 5-7, 9-10, 12-14, and 16-20 are similarly patentable, not only because of their dependency from patentable independent claims, but also because of the additional features of the invention they defined.

In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections to the claims. Accordingly, Applicants submit that claims 1-3, 5-10 and 12-20 are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary. Please charge any

deficiencies and credit any overpayments to Attorney's Deposit Account Number 09-0458.

Respectfully submitted,

Dated: 3/30/06

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